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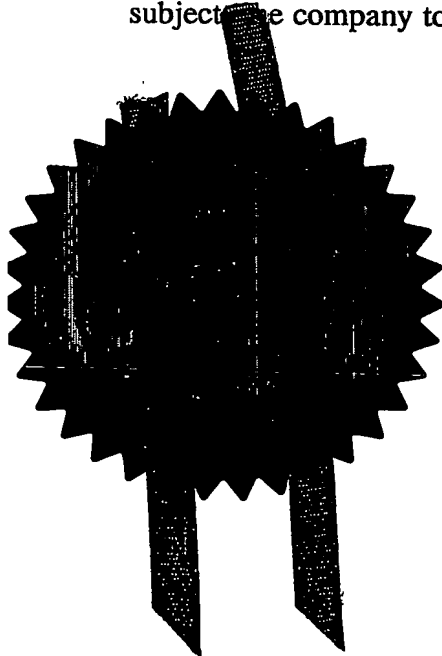
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1. Your reference Veri 9 114753

2. Patent application number
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30 NOV 2002

0228083.2

3. Full name, address and postcode of the or of each applicant (underline all surnames)

Det Norske Veritas AS
Veritasveien 1
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NORWAY

08518987001

Patents ADP number (if you know it)

If the applicant is a corporate body, give the country/state of its incorporation

Norway

4. Title of the invention

A METHOD FOR IMPROVING THE STRENGTH AND CARRYING CAPACITY OF EXISTING STIFFENED PLATE STRUCTURES, CORRUGATED STRUCTURES AND STRUCTURES IN GENERAL IN MARINE VESSELS

5. Name of your agent (if you have one)

SAM BRIDGES
ONSAGERS AS

"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)

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20 EASTBOURNE TERRACE
LONDON W2 6LE

Patents ADP number (if you know it)

08273419002

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Country

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Number of earlier application

Date of filing
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Description 4

Claim(s) 2

Abstract one

Drawing(s) 2

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A method for improving the strength and carrying capacity of existing stiffened plate structures, corrugated structures and structures in general in marine vessels

5 The present invention is related to a method for improving the strength and carrying capacity of existing stiffened plate structures, corrugated structures and structures in general in marine vessels.

The content of the co-pending patent application GB 2002 XXXX is by this included by reference.

10 Vast operational experience from the world's bulk carrier fleet indicates that corrugated bulkheads may be a weak link in the overall safety performance of bulk ships. There have been many cases with loss of older ships in which it has been suspected that the bulkheads have collapsed after water ingress into cargo holds leading to rapid bulkhead failure and sinking of the ship. It is thus of great importance to be able to provide efficient and cost-effective ways of strengthening existing bulk ships as well as other types of merchant vessels.

15 The aim of the invention is to achieve a method to improve the carrying capacities of existing structures in various forms of constructions. One example of a construction is a marine vessel or ship consisting of an outer hull, bulkheads and deck-structure. Another aim is to achieve a strengthened corrugated plate and a strengthened bulkhead.

20 These aims are achieved with the invention as defined in the following claims.

The invention comprises a method for improving carrying capacity of existing structures. With existing structures is it meant structures already used in constructions like ships or vessels, for instance hulls, decks or bulkheads or other structures like stiffened plates used in construction where the carrying capacity of the structure used should be improved. With existing structures one also considers ready manufactured structures like plates not yet used in a construction, but which structures should get improved carrying capacity before they are used in a construction. The improved carrying capacity includes several functions, as for instance general strength, improved capacity to withstand transverse pressure or point loads, high stiffness etc. The concrete used to fill the void created by attaching another plate-element to the existing structure is a concrete with sufficient strength and appropriate density. For weight sensitive structures like ships it may be advantageous to use specially developed concretes that are significantly lighter than both normal concretes and light weight concretes. Normal concretes have density 35 2300 to 2500 kg/m³ whereas light weight concretes used for instance in offshore constructions in the North Sea often have a density of about 1900 kg/m³.

When an existing structure in a construction is improved according to the invention other parts of the construction like a void formed with a box girder, support stool, knee bracing or similar may also be improved in relation to carrying capacity to give the construction an overall improved performance.

- 5 To make sure that the void created by attaching the plate-element is filled totally with concrete, the concrete is filled through one or several access to the void and one or several apertures are present in the proximity of the vertical highest portion of the void. By filling the void until concrete is present in the aperture(s) in the proximity of the vertical highest portion one can with high certainty say that the
10 void is evacuated for air and fully filled with concrete. The apertures to the void may be made after the plate-element is attached to the existing structure or as a consequence of the attaching of the plate-element or it may be a predrilled hole in the plate-element or existing structure.

- 15 Depending on the use and form of the existing structure, other plate-elements may be attached to either one or both sides of the plate.

- The existing structure may be a stiffened structure and the voids created by attaching plate-elements may be of several forms for instance longitudinal in one or several directions. The existing structure may also be corrugated, having alternating mainly parallel ridges and grooves. The ridges and grooves may be formed with
20 sharp angles, rounded bends or more quadrangular forms when looking at the existing structure at a cross-section. There is also the possibility that only a part of the existing structure is corrugated. Another option is that the stiffeners or grooves in the longitudinal direction only run over a part of the existing structure. This may for instance be the case for a bulkhead, where the transitional top and bottom parts
25 of the bulkhead is made as a so-called stool structure with an internal void running mainly parallel with the bulkhead and the hull or deck, whereas the middle part is a corrugated plate structure with grooves running in a mainly vertical direction.

- For an existing corrugated structure one possibility for improving the carrying capacity is to make a plate-element cover one groove and to weld this plate-element
30 to the ridges of the existing corrugated structure. By doing this for all grooves on one side one achieves a smooth surface. First of all, this increases the transverse strength as well as inplane stiffness for horizontal and shear loads. Moreover the smooth surface is favourable in the cases where the existing structures surface is supposed to be cleaned at regular intervals. This is typically the case of bulkheads
35 forming cargo holds in a vessel. By having smooth sides the hold may be cleaned efficiently. In some cases such a strengthened hold may even be used both for cargo and for ballast water. In most cases, however, the main benefit by the current invention is that strength and safety become greatly improved thereby facilitating

satisfaction of formal safety requirements and possibly also extending the life time of the structure.

If the existing structure is a typical stiffened plate structure rather than a corrugated plate, one can achieve a void to be filled with concrete in several ways. One possibility to form such a void is to attach a plate element to the web or flanges of the adjacent stiffeners or girders. The void is thus formed between the existing primary plate structure and the attached plate element. The plate element may have a different thickness than the existing plate structure. The function of the added plate-element is to keep the later injected concrete in place, to provide additional strength, to serve as a protection of the concrete, to provide a smoother surface in relation to the existing stiffened plate structure, etc. The plate element does not have to be fully parallel to the existing plate structure, and it may also in some cases be curved or concave.

Since the strength and carrying capacity is improved with the invention the stiffener means may not be fully necessary any more and may therefore be partly removed so that they no longer protrude outside the attached plate elements. This removal may be done after but preferably before or as a part of the attaching of the plate elements to the stiffener means, so as to form a smoother surface of the cargo hold or compartment.

The invention also includes an improved corrugated plate with, on one or both sides at least one plate-element attached, by welding or fastened in another way, to the ridges of the corrugated plate so that the plate element covers at least one groove and forms a void. This void is filled with concrete with density significantly less than that of normal concrete, preferably less than about 1200 kg/m^3 . By doing this to all the grooves on one side a smooth surface of the originally corrugated structure is created. This may be favourable for instance for corrugated structures, used in bulkheads, since cargo holds should be emptied in a best possible manner and may have to be cleaned very well since different cargos should be transported in the same hold.

The invention also covers structures in vessels like for instance bulkheads, side walls, bottom structures etc with improved strength and carrying capacity made according to the method for improving existing structures.

In the following the invention will be explained with embodiments with reference to the figures where:

Fig. 1 shows a perspective view of a part of a bulkhead improved in accordance with the invention,

Fig. 2 shows a cross-section of a part of an improved corrugated plate.

Fig. 3 shows a cross-section of a part of an improved structure with stiffening means.

Fig. 1 shows a simplified, perspective view of a cut-out section of a ship consisting of, in parts, a bulkhead 1, a lower stool 14 for the bulkhead, a bottom plate 13, and a ship side 12. The bulkhead is made of a trapezoidal type corrugated plate 1 which is welded to the lower support stool 14 which in turn connects the bulkhead with the ship bottom structure 13.

The corrugated plating of the bulkhead is strengthened by attaching new plate elements 2 to the existing structure for forming voids 4. The thickness of the added plates 2 may be less than the thickness of the corrugated plate. The voids 4 are filled with concrete 3. In addition the void 4b in the bulkhead stool 14 is filled with concrete 3. This is to give the overall bulkhead structure matching stiffness and strength properties throughout.

A cross-section of a part of a corrugated plate improved in accordance with the invention is shown in Fig. 2. The corrugated plate forming the existing structure 1 has grooves 6 and ridges 7. The plate-elements 2 are attached or welded to the ridges 7 on both sides of the existing structure and thereby forming smooth surfaces on both sides of the corrugated plate. The voids 4 are filled with concrete 3.

Constructions like ships and marine structures are to a large degree formed with stiffened plate structures. The invention may be utilised for these constructions as well. The existing structure comprises in these cases, as shown in a cross-section in Fig. 3, of a plate 16 and stiffener means 15. The stiffener means 15 may for instance be bulb profile stiffeners or plate girders. The plate-elements 2 are attached to the stiffener means to form voids 4. The voids 4 are then filled with concrete 3. The parts of the stiffener means 15 that protrudes outside the layer of attached plate-elements 2 may be removed if the remaining strength is sufficient, as indicated for two of the stiffeners means 15 by dotted lines in Fig. 3. This removal may be done either before or after the plate-elements 2 are attached. The removal of the parts of the stiffener means 15 results in a smooth surface, where it before the improvement with the present invention were many protruding stiffeners and corners.

The present invention is now explained with examples, but several amendments and changes can be done within the scope of the inventions as defined in the following claims.

CLAIMS

1. Method for improving carrying capacity of existing structures, with the following steps:

- attaching at least one other plate-element to the existing structure to form a void,
- filling the void with concrete with density significantly less than that of normal concrete, preferably less than about 1200 kg/m^3 to the void, and
- letting the concrete cure.

2. Method according to claim 1, wherein other voids in the existing structure is filled with concrete, with a density significantly less than that of normal concrete, preferably less than about 1200 kg/m^3 to the voids.

3. Method according to claim 1 or 2, wherein

- making before adding the concrete at least one aperture in the proximity of the vertical highest portion of the void to facilitate evacuation of air and for determining when the void has been fully grouted,

- adding concrete to the void through at least one other access to the void.

4. Method according to claim 1 or 3, wherein plate elements are attached to both sides of the existing structure to form voids.

5. Method according to one of the preceding claims, wherein the existing structure is a corrugated structure having alternating mainly parallel ridges and grooves and the at least one other plate-element is attached such that it covers at least one groove in the corrugated plate and thereby forms at least one void.

6. Method according to one of the preceding claims, wherein the plate-element covering a groove in the corrugated existing structure is attached by welding or other ways of attaching the sides of the plate-elements to the ridges in the corrugated existing structure.

7. Method according to one of the claims 1-3, wherein the voids are formed by plate-elements attached to stiffener means being parts of the existing structure.

8. Method according to claim 7, wherein the stiffener means are modified before or after plate-elements are attached to them to form voids.

9. Improved corrugated structure with alternating mainly parallel ridges and grooves, wherein it comprises on one or both sides at least one plate-element, attached to the corrugated plate so that the plate element covers at least one groove

and forms a void, which void is filled with a concrete with a density significantly less than that of normal concrete, preferably less than about 1200 kg/m^3 .

10. Improved corrugated structure according to claim 9, wherein all grooves on at least one side are covered by plate-elements, thereby forming a smooth surface.

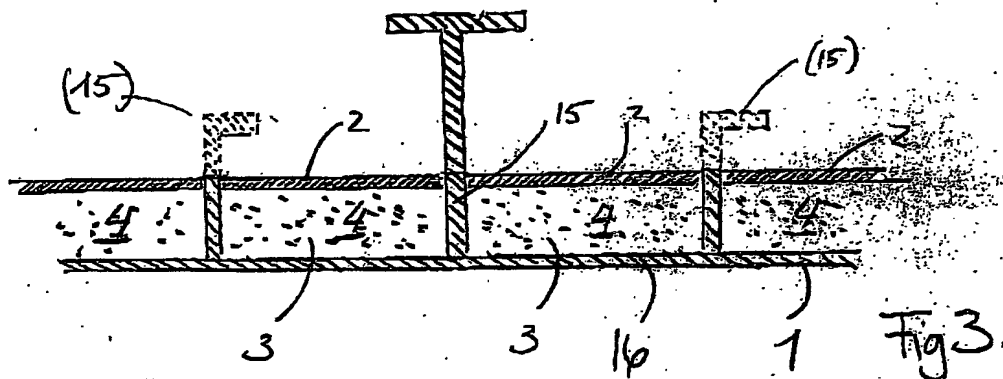
5 11. Structures in ships or vessels like for instance bulkheads, side walls, bottom structures etc with improved strength and carrying capacity made according to the method described in one of the claims 1-8.

ABSTRACT

The present invention relates to a method for improving carrying capacity of existing structures, with the following steps of attaching at least one other plate
5 element to the existing structure to form a void, thereafter filling the void with concrete with density significantly less than that of normal concrete, preferably less than about 1200 kg/m^3 to the void, and
10 then letting the concrete cure. The invention also includes a improved corrugated structure and structure for use in ships or vessels.

Fig. 1





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